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Simulex simulations on the evacuation of day-care centres for children 0-6 years

L. Ulriksen¹ and A. S. Dederichs²

Performance based codes are successively introduced across the world [Fleischmann, 2011]. Applying the methods of fire safety engineering requires models describing the evacuation of people from buildings [Frantzich, 1994]. Data from evacuation experiments are used for validation and adjustments of such models [Kuligowski et al., 2010]. Children account for 15-20% of the western world's population [Larusdottir et al., 2010; Nordic statistical yearbook, 2009] and evacuation models should be validated using data taken from this group in order to ensure the safety of this population and to fulfill the growing demand on "equal egress". One of such models frequently applied in fire safety engineering is Simulex [Thompson et al., 1994, 1995]. The model is widely applied within fire safety design. The model is designed also to model evacuation of children.

The purpose of the current study is to compare the results from simulations with Simulex 1.2. [Frantzich, 1998] on the movement of children in the age 0-6 years during an evacuation with real data from experiments [Larusdottir et al., 2010]. Comparisons of total evacuation times are shown and discussed in this abstract, walking speeds on horizontal plane and on stairs are discussed in this abstract, the results of flow through doors and walking speeds on horizontal plane and on stairs will be presented and analyzed in the proposed paper.

Computer simulations applying Simulex 1.2 of 9 different day-care centres are carried out. In Danish day-care centers children at the age of 0-6 years are divided into two groups: *younger children* at the age of 6 months to 2 years and *older children* at the age of 3 to 6 years, i.e. crèche and kindergarten. The results of the simulations are compared with data from real experiments from evacuation exercises [Larusdottir et al., 2010] at the same day-care centres.

Following general assumptions are given in Simulex:

- Each person is assigned a normal unimpeded walking speed
- Walking speeds are reduced as people get closer together
- Each person heads towards an exit by taking a direction which is at right angles to the contours shown on the chosen distance map
- Overtaking, body rotation, sideways stepping and small degrees of back-stepping are all accommodated.

In these simulations occupants are defined as children only. In the simulations, all the children are walking since it is not possible to specifically define running children. Furthermore, Simulex does not differentiate between different age groups; occupants are just defined as children.

The day-care centers have three spiral stairs. In the model the stairs are defined with the true length of the staircase, the slope length added the length of the landings. The width of the spiral stair should be defined so narrow that it is not possible for occupants to overtake each other. Stairs are shown as straight stairs [Frantzich, 1998].

The egress time is defined as the time from the first occupant starts moving, until the first occupant respectively the last occupant exits the day-care centre. Reaction and decision time are assumed to be neglectable due to the teachers' knowledge about the exercises. The warning times found in the exercises is added to the walking time. **Figure 1** shows the total

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evacuation times from the simulations compared to the times found in the evacuation exercises.

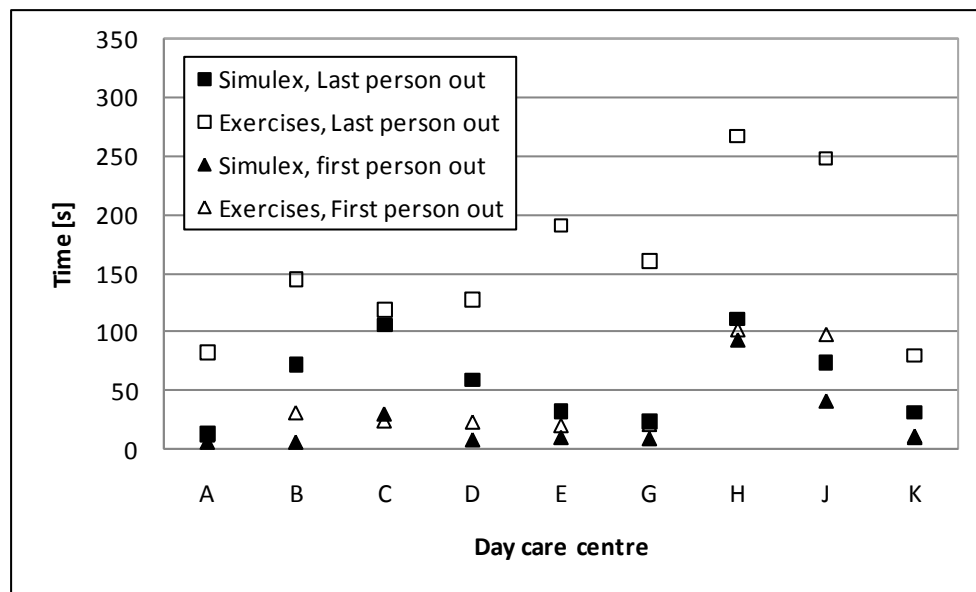


Figure 1 Total evacuation times found in Simulex compared to real data.

The results show that the simulated times are lower than the times from the real data. This applies both to the times for the first person out and the last person out. However, there is a better compliance between the times for the first person out which could also be expected. The small gap between simulation and experiment can partly be explained by the fact that the reaction and decision time are neglected. The difference between the times for the first person out in the exercises respectively Simulex varies between 7 seconds and 56 seconds. The difference on 56 seconds is for a day-care centre where the children put on outerwear before leaving the building.

Results of the walking speed in horizontal plane will be shown in the proposed paper. The results from the exercises give a higher travel speed for the older children running than the average walking speed found in Simulex. The travel speed for the younger children running complies well with the average walking speed found in Simulex. However, only a few children and not enough consistency to use the numbers in e.g. a design phase for a building. Furthermore, the spread of the experimental data of the travel speeds is larger than from the simulations. Except for the few children running, the walking speed found in the simulations in Simulex is higher than the walking speed found in the exercises for both age groups. The walking speeds from the simulations correspond better with the results from the exercises for children running but still not completely.

Familiarity with the escape-route mattered with respect to travel speed along the three stairs. It is not possible to simulate occupant's knowledge and familiarity to a given stair. Except for the initial escape in the familiar staircase, the simulations overestimate the travel speed on stairs.

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